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# **Problems with Off-Line UPS Systems**

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Competitive Analysis of Off-Line UPS Systems



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## Competitive Analysis of Off-Line UPS Systems

### Abstract

The following is an outline of some of the major problems associated with off-line (stand by) UPS designs. A one line diagram of a typical off-line system is attached for your review. (see **Figure 1.**)

### Input frequency/voltage pass through

The off-line unit is designed to pass through the input line voltage and frequency to the load. (Note: the power passed through is non-conditioned utility power.) While this may be fine for office environments, it is not acceptable for industrial settings with periodic voltage and frequency deviations. Due to the design of off-line systems, some of the deviations will be passed directly to the loads, causing loads to drop and/or loss of data. Off-line UPS suppliers could tighten input parameters so these levels of voltage and frequency are not passed through. However, this would require the systems' batteries to assume the load more frequently. As you will see in point #2, this can also have some troubling results.

### Battery pickup

If the input voltage and frequency deviate outside of acceptable limits, the systems' batteries will automatically assume the supply of the charger/inverter. While this mode of operation rectifies the problem of voltage and frequency pass through, It can cause other serious problems.

First, if the voltage and frequency deviate (for example every time a motor or pump starts up) then the system will be operating on its batteries. The batteries supplied with off-line systems are a valve-regulated "maintenance free" type. These batteries are very sensitive to cycling. (Cycling is defined as any time that the battery supplies current to the load.) Cycling is not time dependent, so a one minute discharge is just as bad as a ten minute discharge. A battery is designed to supply only a certain number of cycles over life. (Note: valve-regulated batteries have a limited number of cycles, even less than other battery types.) Therefore, it's not hard to imagine what will happen when an off-line system is supplied for an industrial setting. The constant starting of motors, pumps and other electrical devices will result in voltage deviations outside the limits of the pass through logic. This will result in the systems batteries being cycled each time it occurs. Eventually, you will exceed the limited number of cycles available and the batteries will fail. This will undoubtedly happen when you least expect it, and you will probably not be aware of the condition. The result is that you will drop your critical load and also have to replace your batteries.

Another problem associated with the battery pickup feature is that even if the batteries are functioning normally failure may occur because of a lack of recharge current. Typically, off-line UPS systems are not supplied with fully-rated chargers. Instead the systems are supplied with a "trickle chargers." These "trickle chargers" are not designed to quickly recharge the system's batteries after a discharge. If the batteries are being cycled often, the result is that the "trickle charger" may not be able to fully recharge the batteries in-between discharges. The batteries can be discharged to a state from which they can no longer supply the required current to your critical loads. Not only does this damage the system's batteries, but it will also drop critical loads.

### Inability to handle nonlinear loads

Off-line systems do not handle nonlinear (crest factor) loads well. Therefore, in order to supply these types of loads, off-line systems must often be oversized. (Note: Typical nonlinear loads are DCS systems and computer loads.) If

the systems are not oversized to handle these types of loads, they will deprive the load of necessary current, resulting in the "flat topping" of the current wave form. The result would be loss of data and/or system failures.

## **Sizing of system's components**

As we have seen in items 1 and 2, there are some serious design concerns associated with off-line designs. There are also component sizing concerns. (Some off-line manufacturers do not size the components utilized in the chargers and inverters to handle the systems full load on a continuous basis.) The thought process is that the station line voltage, frequency and current are going to be normally passed directly through to the loads. However, as we have already noted, the off-line design, when utilized in an industrial setting, will require the inverter to supply the critical loads on a fairly regular basis. It stands to reason that the undersized components utilized in an off-line design will fail more often because they were never intended for continuous duty. It must also be noted that when the off-line system utilizes its charger/inverter, it is functioning in a most precarious position. If any component fails during this operation mode, your critical load will be dropped. However, in the off-line system you may never know if a component has failed until needed because the only time the charger/inverter components are turned "on" is when it is needed to supply your critical load. This is very much like a light bulb, it only blows when power is applied and you can never predict when it will happen.

## **Lack of overload/ system protection**

What happens if a downstream fault occurs? The off-line system would drop the load because it is not supplied with a static switch, there is no capability to supply high levels of fault current to the load. This point alone shows that the off-line design was never designed for primary use in an industrial environment. Industrial environments require a capacity for high fault-clearing capabilities. Office environments do not require this type of current capability.

We feel that the above points illustrate the failings of a off-line systems in an industrial atmosphere. It is not our intent to say that the off-line system are not a viable design. What we are saying is that we do feel that off-line designs are not reliable for long term operation in industrial environments. Off-line systems are typically manufactured for office type environments which do not place the demands on the system that an industrial environment does.

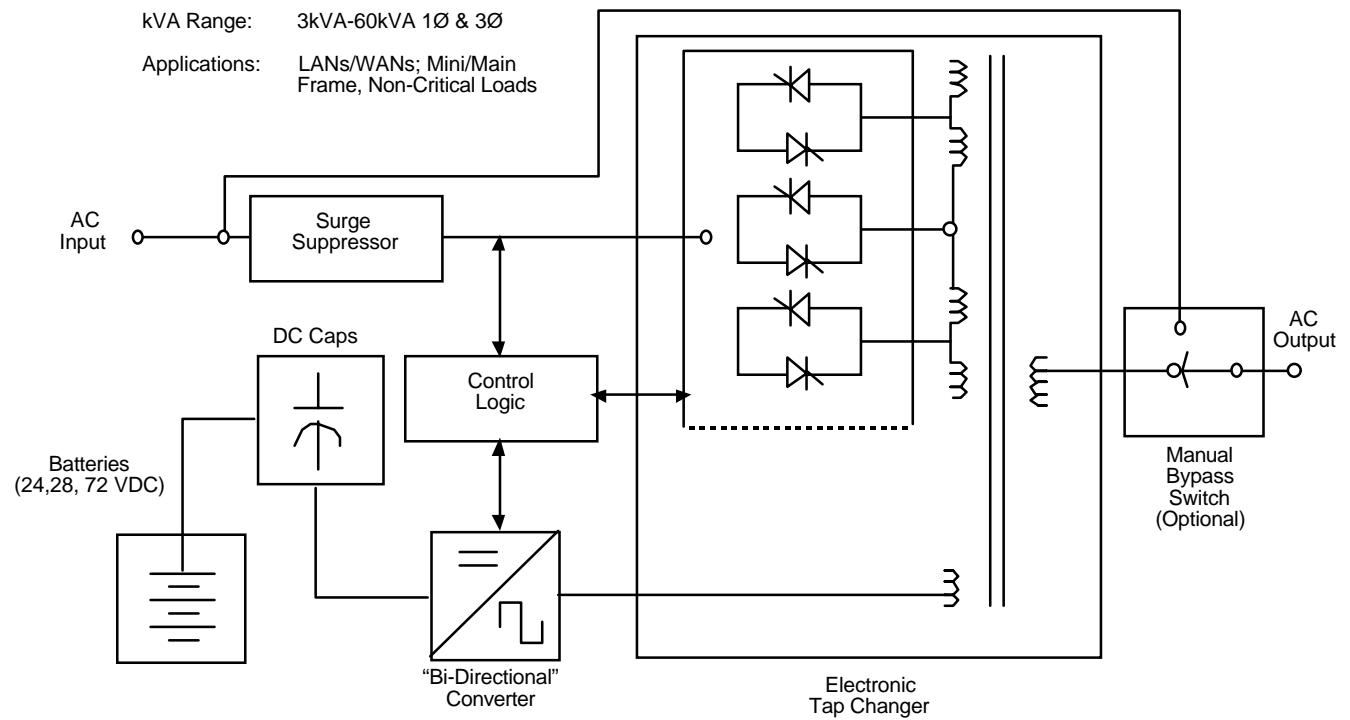
## **Attachment #1**

### **Solidstate Controls Double Conversion Differences**

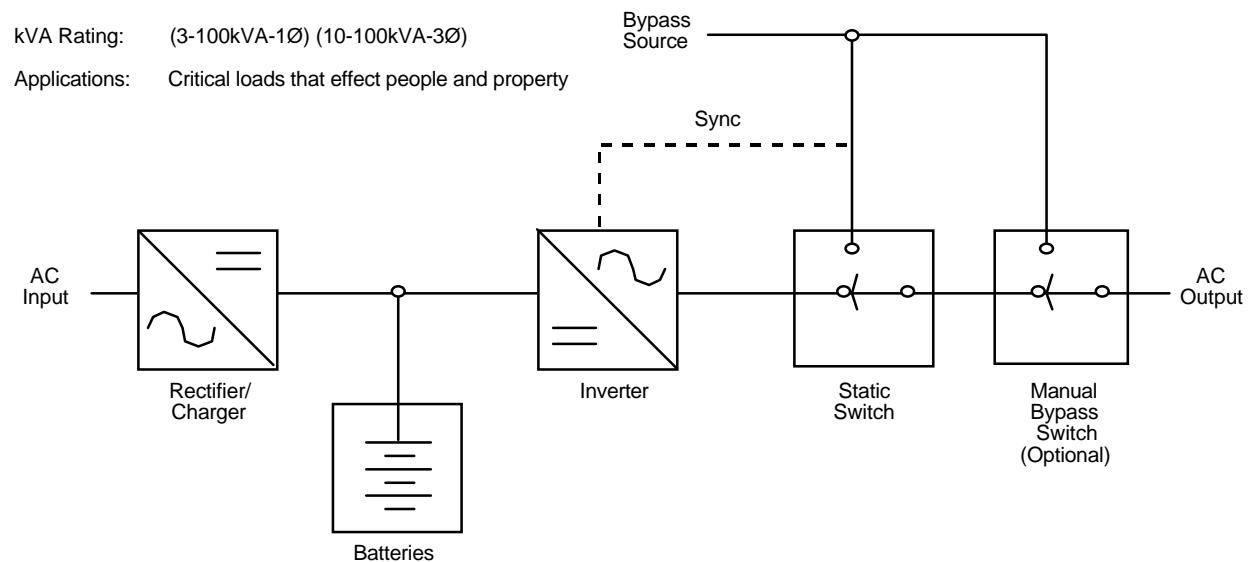
Solidstate Controls systems differ from off-line designs in the following ways:

1. Solidstate Controls offers an on-line, double conversion UPS system. Therefore, the client's critical load is being powered continuously from the inverter. The battery is always being floated by the fully-rated rectifier/charger and is always connected to the inverter input. As result, all components used in the Solidstate Controls design are fully rated to carry 120% of the load on a continuous basis over a 20-year life.
2. Solidstate Controls' ferroresonant design has a built in capacity to supply nonlinear (crest factor) loads of up to 3:1 without oversizing.
3. Solidstate Controls' on-line UPS design is provided with a make-before-break static switch to aid in downstream fault clearing and to protect against possible system failures.
4. Solidstate Controls' on-line UPS system is a double conversion type, converts AC to DC and then reconverts DC back to AC. It is also insensitive to frequency deviations at the primary input.
5. Solidstate Controls' on-line UPS system is designed to handle input voltage deviations of +10% to - 15% without causing the battery system to take over the inverter's load. This reduces the UPS systems reliance on its battery, thereby increasing the life of the battery system.

Note: A one-line diagram of a typical Solidstate Controls' on-line double conversion UPS system is attached . See **Figure 2** below.



**Figure 1** "Off-Line" System—Hybrid B. Single Conversion, Line Interactive, Bi-Directional



**Figure 2** "Online" System—UPS Block Diagram. Double Conversion/Non-Redundant